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Studies of Feasibility of Intercropping of *Camelina sativa* in Jatropha Plantation in Semi – Arid Climate in Andhra Pradesh, India

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Abstract

The article describes the feasibility of intercropping of Camelina sativa in jatropha plantation in semi–arid climate in Andhra Pradesh. The normal agricultural practices were adopted during the intercropping experiments. The yield of Camelina sativa was 1100-1700 kg ha^{-1} and improved to 2000 – 2200 kg ha^{-1} on rotating the crop with leguminous fodder crops. The oil content in the seed was in the range of 27.6±0.5%. Intercropping of Camelina sativa may be recommended as alternate oilseed crop for biofuel in jatropha plantation.

Keywords: Feasibility, intercropping, semi-arid, *Camelina sativa*, pod, oil content.

Introduction

The increasing demand of depleting fossil fuel as well as increasing environment concern is the major challenge of the present time. Research and development activities throughout world are focused on searching of the feedstock to produce environmental friendly fuels and chemicals. The biomass from plant origin is one of the alternative sources. Oilseed crop are the potential sources to derive fuels and chemicals. The vegetable oil sources such as soyabean, palm, rapeseed, are the major feedstock whereas more focused are non-food oilseed crops such as Jatropha, Pongamia, and Camelina. The current article describes the agricultural practices of Camelina in semi-arid zone of Andhra Pradesh, India. *Camelina sativa* is an annual oilseed plant of family Brassicaceae belongs to order Brassicales. It is usually known as gold of pleasure or false flax. The plant is native from Finland to Romania and east to western Ural Mountains. The crop is well adapted to temperate zone. It germinates at low temperature and seedlings are highly frost tolerant. This versatile crop has been cultivated in Europe since the Bronze Age. The seeds are used as oil for food, medicinal purpose and lamp oil. It has an almond like flavor and aroma. The oil contains high level of Omega-3 fatty acid which is uncommon in other vegetable oils.

Description: Camelina is a short duration crop of 85-100 days[1]. Camelina can be grown in black and laterite soil. The plant can grow well in coarser textured or shallow, droughty on marginal land relatively poor and saline soil. It can be better grown in low rainfall in comparison of other oil seed crop[1]. The plants grow up to a height of about 30-90 cm. The seed pod formation takes place on upper part of plant 5.0-7.5cm of plant. The leaves are long and arrow shaped. Camelina seed contains 30-40% oil[2]. Camelina seed pods resemble flax balls. The seeds have rough surface with 1000 seed weight in the range of 0.8 to 2.0 gm. It is low input crop in terms of Agronomic practices. In spite of high unsaturation, Camelina oil is more stable due to presence of natural antioxidants towards oxidation than other highly unsaturated oil. Camelina meal contains glucosinolates in the range of 13-36 µmolgm^{-1} and has been used in animal feed rations[3]. Camelina meal is similar to soyabean meal with 45 to 47 percent crude protein and 10 to 11 percent fibre. The acid value of crude Camelina oil is 2.06±0.04 mg KOH gm^{-1} [4]. Camelina yields 336-2240 kg of seeds per hectare in semi arid and tropic[3]. The Camelina oil may be used as feedstock for fuels and industrial products as shown in figure-1.

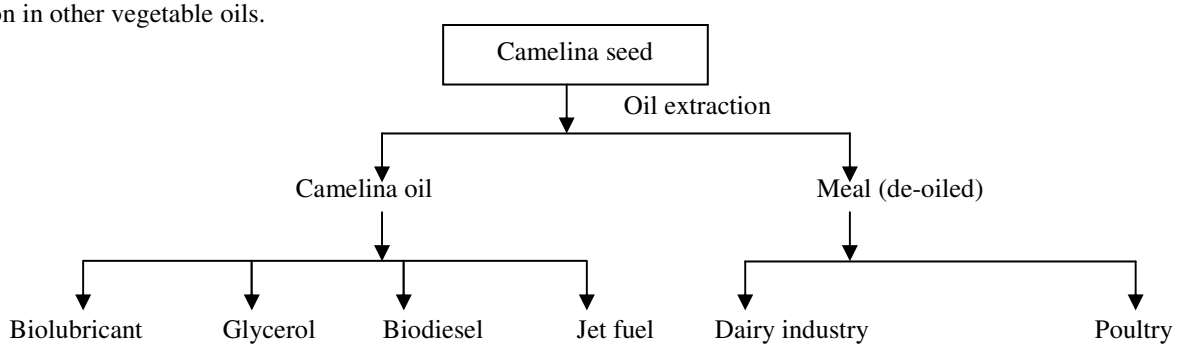

Figure-1
Production of Biodiesel and value-added products from *Camelina sativa*

Material and Methods

Procurement of Camelina seed: A small quantity of nucleus seed of Camelina cv Calena (EC- 643910) was procured from NBPGR, New Delhi following the one rotation of crop at DIBER field station Pithoragarh in 2009[5], the harvested seed was intercropped with Jatropha at DRDO-DIBER Project site Secunderabad, A.P (India) for three sequence years (2009-2011). Branching was noticed more (between 6-12) in comparison to north India as shown in table-1.

Agricultural practice adopted for Camelina cultivation: Agricultural practices followed and the inputs for cultivation of Camelina are described in table-2. The soil was added with DAP, FYM and proper harrowing was done prior to seed bed preparation. The weeds such as Congress grass were removed manually from Camelina cultivation plot. The seeds were sown by broadcasting method. 180 gm of seeds were sown in 12 plots having length 4m, width 2m in three rows. Irrigation was done for four times, the first watering was done after 20-25 days of germination, secondly after attaining the plants height of 05cm, the third one during flowering and fourth during 50% pod setting stages.

Table-1
Results of *Camelina sativa* cultivation

Plot no.	Date of sowing	Germination Percentage	Average. Plant Ht. (cm)	Average. Branches /plant	Average Seeds pods/ plant	Days to harvest	Yield (gm) in $8m^2$
R1.	15.11.2009	70	43.5	11.3	183.4	87	980.6
R2.	15.11.2009	65	46.3	10.6	160.5	84	960.9
R3.	15.11.2009	60	41.0	6.5	130.5	95	920.3
R4.	15.11.2009	70	50.75	12.4	190.8	84	960.5
R5.	15.11.2010	65	51.5	7.8	160.3	84	966.3
R6.	15.11.2010	40	47.5	12.3	120.5	89	905.8
R7.	15.11.2010	70	43.3	11.7	190.8	88	985.4
R8.	15.11.2010	50	47.25	7.6	80.5	84	750.7
R9.	15.11.2011	70	47.5	9.6	160.8	102	950.3
R10.	15.11.2011	80	51.5	12.4	201.0	97	1020.6
R11.	15.11.2011	70	47.3	12.8	180.6	91	930.5
R12.	15.11.2011	60	37.3	7.3	160.5	89	943.6

Table-2
Agricultural field data on growing of *Camelina sativa*

Parameters	Details
Land preparation	After watering and FYM broadcasting on soil surface, land is ploughed by disc plough.
Soil Application, FYM/compost/ fertilizers (dose: kg ha^{-1})	soil is treated with FYM 65 kg ha^{-1}, Fertilizer DAP: 25 kg ha^{-1}
No. of trials	03
Plot size	4 m length, 2 m width (12 Plots)
Number of plots	12 plots
Plant population per plot	950-1100 (Approx)
Inter cropping	Camelina sativa with jatropha plantation
Seed rate	10-20 gm
Spacing	Each bed three rows, row to row 50cm
Method of sowing	By broadcasting in each plot in three rows.
Germination	50 percent emergence comes within 10-12 days. Average germination % 60-80
Intercultural operation	Weeding (Congress Grass) is done manually.
Irrigation	1^{ST} Irrigation 20-25 days after emergence, 2^{nd} irrigation during 05 cm height, 3^{rd} irrigation after 50 % flowering and 4^{th} irrigation during 50% pod setting.
Flowering	50 % flowering comes after average 40-60 days
Pod setting	50 % pod setting takes place after average 60-70 days
Days to maturity	maturity comes after 85-100 days of sowing
Data on seed oil content	27.6 ± 0.5% oil content found

Results and Discussion

A fine seed bed ensures proper seed germination. Fertilizer such as DAP @ 25kg/ ha and FYM @65kg/ha was added during bed preparation. The seed was mixed with moist soil and was kept overnight. For the even distribution of seed, sand was mixed before sowing. The average germination percentage found 40-80%. 50% flowering comes after average 40-60 days of the seed sowing done in November of 2009-2011. 50-60% pod setting takes place after average 60-70 days figure-2 and 3. The average plant height varies 37.3-51.5cm. The oil content estimated in the *Camelina sativa* seed to be 27.6±0.5%. Number of branches per plant vary from 7-12. Seeds per pod per plant varies 80-201. Yield in eight square meter land varies from 0.75-1.02kg at DIBER project site, Secunderabad table-1. Camelina has also been shown allelopathic properties[6]. Very few weed such as congress grass was found in Camelina bed. Average seed yield is 1100-1700 kg/ha.

Figure-2
Flowering stage

Figure-3
Pod formation stage

Figure-4
Harvest stage

Figure-5
Camelina seed

Harvest and storage: After 80-85 days of sowing the seed, pods mature as days of sowing the seed were indicated by the pod colour changes from green to light grey figure-4. The harvesting has been done manually when 2/3 of pods become dark grey, followed by thrashing further storage. Camelina pod hold their seed tightly and do not open easily to allow seed dispersal as a result losses from shattering are minimal. This is very unique property of this crop which is not found in any other crop of Brassicaceae family.

Yield and crop rotation: In order to improve the productivity of Camelina seed, crop rotation was done with leguminous fodder crops. After three crop rotation with Berseem and Lucerne on same land figure-6, the yield of the Camelina seed was improved from 1100-1700 kg ha^{-1} to 2000-2200 kg ha^{-1}. Lucerne root nodules contain bacteria *Sinorhizobium meliloti* with the ability to fix nitrogen. The last cut of the berseem has been ploughed into the soil which act as green manure to the soil and contributed approximately 224 kg of nitrogen/ha to soil. It also improved the soil quality of DIBER project site Secunderabad.

Diseases and pest: *Camelina sativa* crop is tolerant of insects and weeds[7].

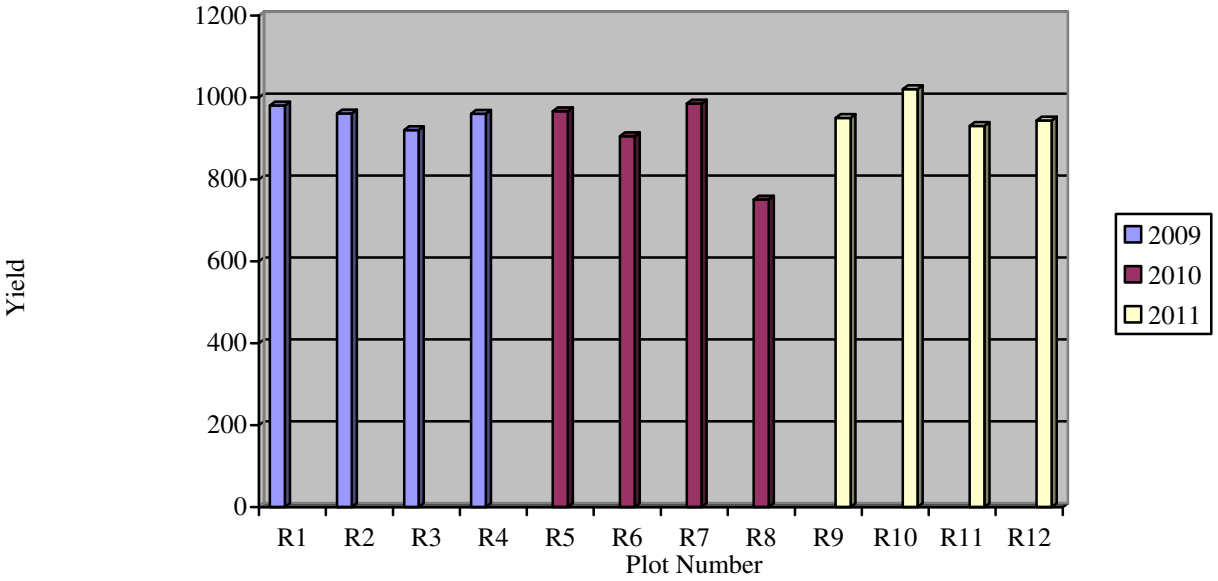

Figure-6
Yearly yield of different plots with respect of crop rotation with leguminous crop

Conclusion

Camelina is a potential oilseed crops, can be easily grown as intercropping in jatropha plantation at the semi arid zone at Secunderabad, Andhra Pradesh. It has unique and promising properties with high oil content and can be used as feedstock for biodiesel, glycerol, biolubricant, jet fuel production and biofuel[8]. Vegetable oil produced from camelina is expected to be cost effective. It can compete regarding cost factor with gasoline, petrol and diesel and will made a revolution and new scope in agriculture in future prospects.

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